

## Title (en)

HEARING ASSISTANCE DEVICE WITH BEAMFORMER OPTIMIZED USING A PRIORI SPATIAL INFORMATION

## Title (de)

HÖRHILFEVORRICHTUNG MIT STRAHLFORMER MIT OPTIMIERTER RÄUMLICHER A PRIORI-INFORMATION

## Title (fr)

DISPOSITIF D'AIDE AUDITIVE AVEC FORMEUR DE FAISCEAUX OPTIMISÉ À L'AIDE D'INFORMATIONS SPATIALES A PRIORI

## Publication

**EP 2986026 B2 20220921 (EN)**

## Application

**EP 15180702 A 20150812**

## Priority

US 201462036361 P 20140812

## Abstract (en)

[origin: EP2986026A1] A hearing assistance system includes an adaptive binaural beamformer based on a multichannel Wiener filter (MWF) optimized for noise reduction and speech quality criteria using a priori spatial information. In various embodiments, the optimization problem is formulated as a quadratically constrained quadratic program (QCQP) aiming at striking an appropriate balance between these criteria. In various embodiments, the MWF executes a low-complexity iterative dual decomposition algorithm to solve the QCQP formulation.

## IPC 8 full level

**G10L 21/0208** (2013.01); **G10L 21/0216** (2013.01); **H04R 3/00** (2006.01); **H04R 25/00** (2006.01)

## CPC (source: EP US)

**G10L 21/0208** (2013.01 - EP US); **H04R 3/005** (2013.01 - EP US); **H04R 25/407** (2013.01 - EP US); **H04R 25/505** (2013.01 - US); **H04R 25/552** (2013.01 - US); **G10L 2021/02166** (2013.01 - EP US); **H04R 2203/12** (2013.01 - US); **H04R 2225/43** (2013.01 - US); **H04R 2430/25** (2013.01 - EP US); **H04R 2460/01** (2013.01 - US)

## Citation (opposition)

## Opponent :

- US 2010002886 A1 20100107 - DOCLO SIMON [BE], et al
- EP 2211563 B1 20110824 - SIEMENS MEDICAL INSTR PTE LTD [SG]
- US 2012027117 A1 20120202 - KHOJASTEPOUR MOHAMMAD A [US], et al
- US 8005310 B2 20110823 - FREI BERNHARD [DE]
- US 2014056435 A1 20140227 - KJEMS ULRIK [DK], et al
- US 2011305345 A1 20111215 - BOUCHARD MARTIN [CA], et al
- EP 2747451 A1 20140625 - FRAUNHOFER GES FORSCHUNG [DE], et al
- A. SPRIET ET AL.: "Robustness analysis of multichannel Wiener filtering and generalized sidelobe cancellation for multimicrophone noise reduction in hearing aid applications", IEEE TRANSACTIONS ON SPEECH AND AUDIO PROCESSING, vol. 13, no. 4, July 2005 (2005-07-01), pages 487 - 503
- S. DOCLO ET AL.: "Reduced-Bandwidth and Distributed MWF-Based Noise Reduction Algorithms for Binaural Hearing Aids", IEEE TRANSACTIONS ON AU - DIO, SPEECH AND LANGUAGE PROCESSING, vol. 17, 1 January 2009 (2009-01-01), NEW YORK, NY, USA, pages 38 - 51, ISSN: 1558-7916
- SIMON DOCLO ET AL.: "Comparison of Reduced-Bandwidth MWF- Based Noise Reduction Algorithms for Binaural Hearing Aids", APPLICATIONS OF SIGNAL PROCESSING TO AUDIO AND ACOUSTICS, 2007 IEEE WO RKSHOP ON, 1 October 2007 (2007-10-01), PI, pages 223 - 226, ISBN: 978-1-4244-1618-9
- CHENGWEN XING ET AL.: "How to Understand LMMSE Transceiver Design for MIMO Systems From Quadratic Matrix Programming", DRAFT, 2 March 2013 (2013-03-02), pages 1 - 31, Retrieved from the Internet <URL:https://arxiv.org/abs/1301.0080v4>
- WEI-CHENG LIAO ET AL.: "INCORPORATING SPATIAL INFORMATION IN BINAURAL BEAMFORMING FOR NOISE SUPPRESSION IN HEARING AIDS", 2015 IEEE INTERNATIONAL CONFERENCE ON ACOUSTICS, SPEECH AND SIGNAL PROCESSING (ICASSP, August 2015 (2015-08-01), pages 5733 - 5737
- ALEXANDER BERTRAND, SIGNAL PROCESSING ALGORITHMS FOR WIRELESS ACOUSTIC SENSOR NETWORKS, May 2011 (2011-05-01)
- CRAIG A. ANDERSON ET AL.: "MULTICHANNEL WIENER FILTER ESTIMATION USING SOURCE LOCATION KNOWLEDGE FOR SPEECH ENHANCEMENT", 2014 IEEE WORKSHOP ON STATISTICAL SIGNAL PROCESSING (SSP, 29 June 2014 (2014-06-29), XP032631188
- MICHAEL BRANDSTEIN ET AL.: "Signal Processing Techniques and Applications", POST-FILTERING TECHNIQUES, 2001, pages 39 - 60
- Ivo Merks et al., "Design of a high order binaural microphone array for hearing aids using a rigid spherical model", 2014 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP), 9781-4799-2893-4, which was added to IEEE Xplore on July 14, 2014
- I.L.D.M. Merks, "Binaural application of microphone arrays for improved speech intelligibility in noise", PhD Thesis, DelftUniversity of Technology, 1999, pages 75-77
- C. Knapp and G. Carter, "The generalized correlation method for estimation of time delay", IEEE Transactions on Acoustics, Speech and Signal Processing 24.4 (1976): 320-327
- R. Roy, A. Paulraj, and T. Kailath, "Direction-of-arrival estimation by subspace rotation methods ESPRIT", Acoustics, Speech, and Signal Processing, IEEE ICASSP'86. Vol. 11. IEEE, 1986
- Brady N.M. Laska; Miodrag Bolic; Rafik A. Goubran, "Coherence assisted Wiener filter binaural speech enhancement", Publisher: IEEE, Published in: 2010 IEEE Instrumentation & Measurement Technology Conference Proceedings, Print ISBN:978-1-4244-28328, Print ISSN: 1091-5281, Date of Conference: 3-6 May 2010, Date Added to IEEE Xplore: 17 June 2010, https://ieeexplore.ieee.org/document/5488166
- Bram Cornelis; Simon Doclo; Tim Van den Bogaert; Marc Moonen; Jan Wouters; "Theoretical Analysis of Binaural Multimicrophone Noise Reduction Techniques", Print ISSN: 1558-7916, Electronic ISSN: 1558-7924, DOI: 10.1109/TASL.2009.2028374, Published in: IEEE Transactions on Audio, Speech, and Language Processing (Volume: 18, Issue: 2, Feb. 2010) https://ieeexplore.ieee.org/document/5173569
- Tim Van den Bogaert; Jan Wouters; Simon Doclo; Marc Moonen; "Binaural Cue Preservation for Hearing Aids using an Interaural Transfer Function Multichannel Wiener Filter", Print ISBN: 1-42440727-3, Print ISSN: 1520-6149, Electronic ISSN: 2379-190X, DOI:10.1109/ICASSP. 2007.366975, Date Added to IEEE Xplore: 04 June 2007https://ieeexplore.ieee.org/document/4218163
- S. Doclo, T. J. Klasen, T. Van den Bogaert, J.Wouters, and M. Moonen, "Theoretical analysis of binaural cue preservation using multi-channel Wiener filtering and interaural transfer functions," in Proc. Int. Workshop Acoust. Echo Noise Control(IWAENC), Paris, France, Sep. 2006.
- Seokhwan Jo; Chang D. Yoo; "Psychoacoustically Constrained and Distortion Minimized Speech Enhancement", DOI: 10.1109/TASL.2010.2041119 Published in: IEEE Transactions on Audio, Speech and Language Processing (Volume: 18, Issue: 8, Nov. 2010) https://ieeexplore.ieee.org/document/5398888
- Bram Cornelis; Simon Doclo; Tim Van den Bogaert; Marc Moonen; Jan Wouters; "Analysis of localization cue preservation by multichannel wiener filtering based binaural noise reduction in hearing aids".

Cited by

US10555094B2; US10425745B1; WO2019222534A1

Designated contracting state (EPC)

AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

DOCDB simple family (publication)

**EP 2986026 A1 20160217; EP 2986026 B1 20180131; EP 2986026 B2 20220921;** DK 2986026 T3 20180507; US 2016050500 A1 20160218;  
US 9949041 B2 20180417

DOCDB simple family (application)

**EP 15180702 A 20150812;** DK 15180702 T 20150812; US 201514819875 A 20150806